Radiometric in-situ measurements over European & African sites for validating LSA SAF's land surface temperature product

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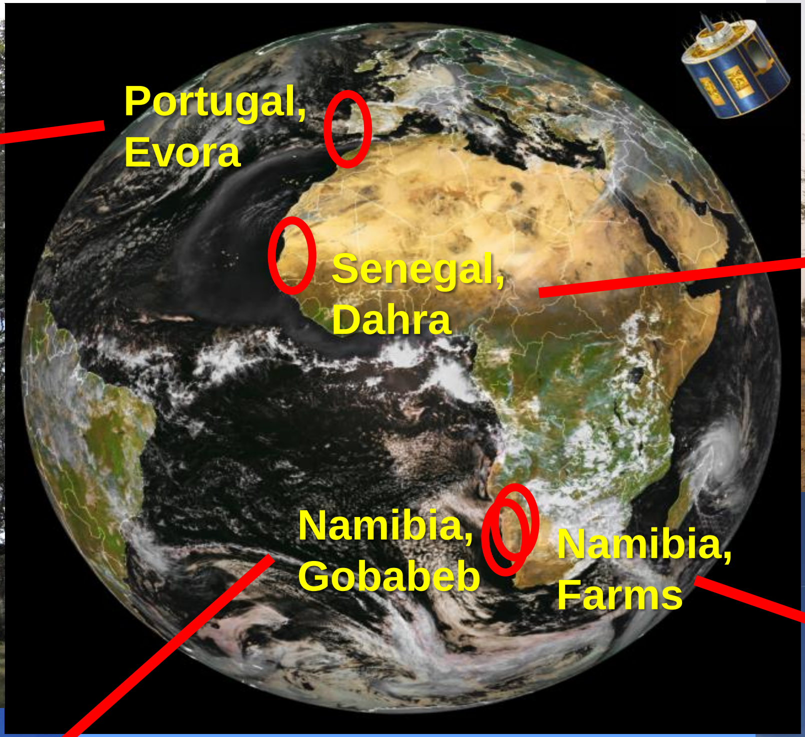
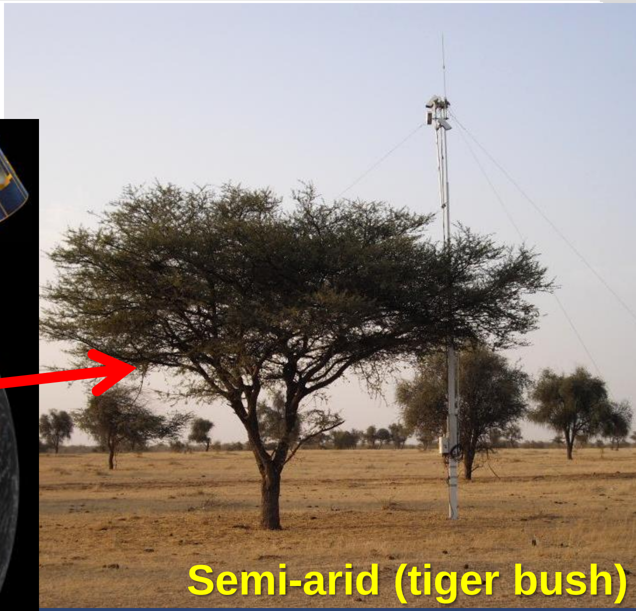
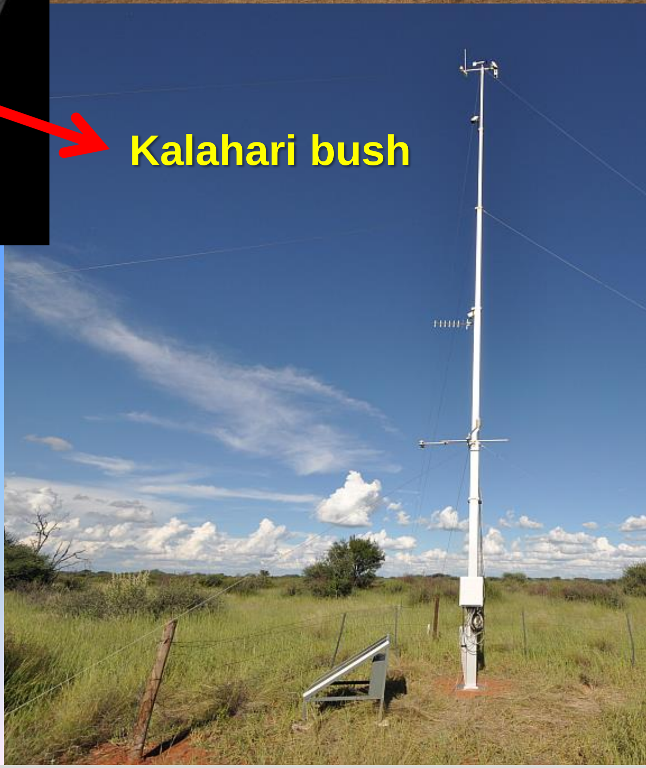
INSTITUTE OF METEOROLOGY AND CLIMATE RESEARCH (IMK-ASF)

LST Validation Sites



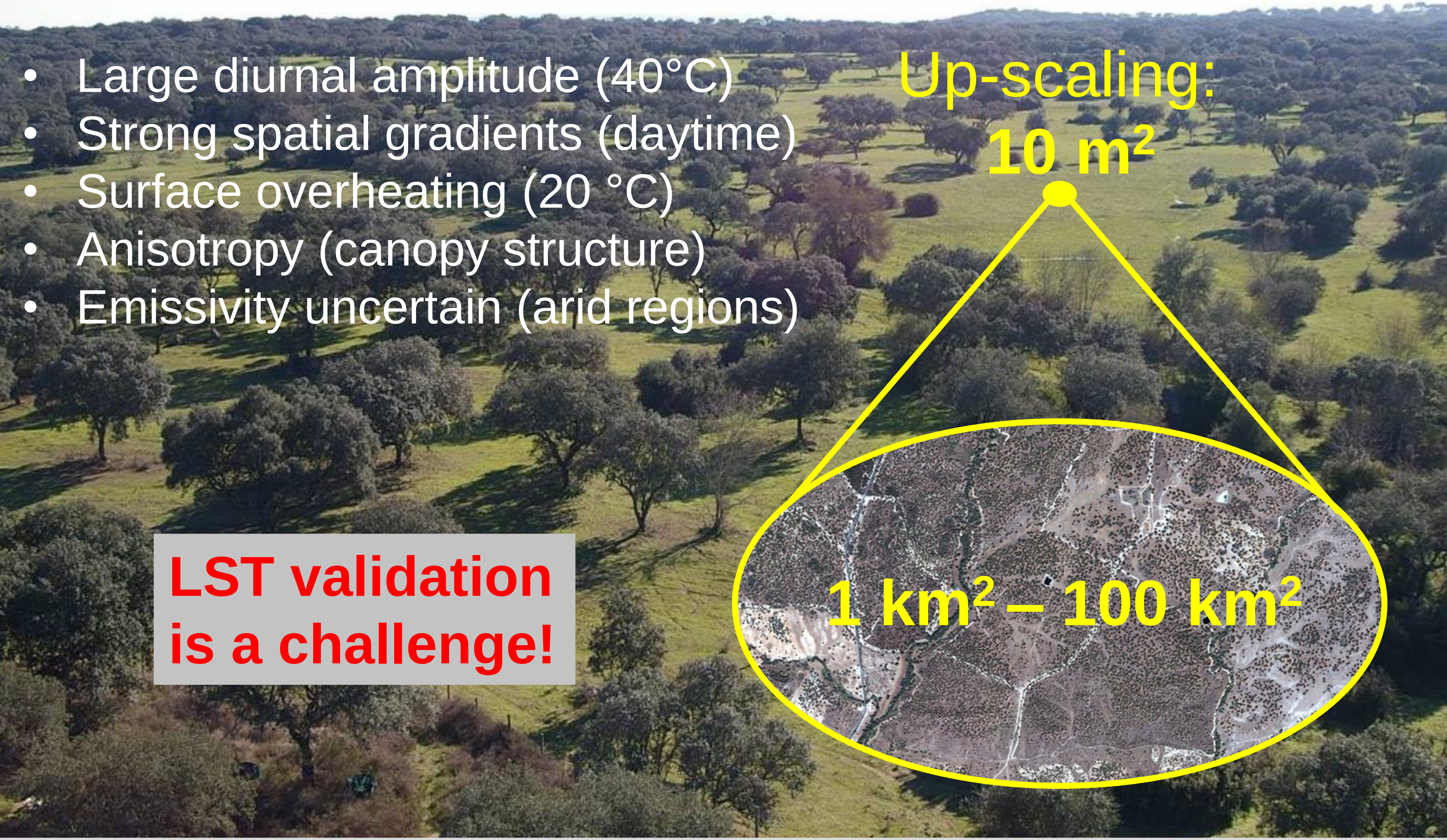




- Large, **homogeneous** sites
- Well **characterised**
- Different climates & biomes
- **Dedicated** to LST validation

Land Surface Temperature (LST)

- Large diurnal amplitude (40°C)
- Strong spatial gradients (daytime)
- Surface overheating (20 °C)
- Anisotropy (canopy structure)
- Emissivity uncertain (arid regions)



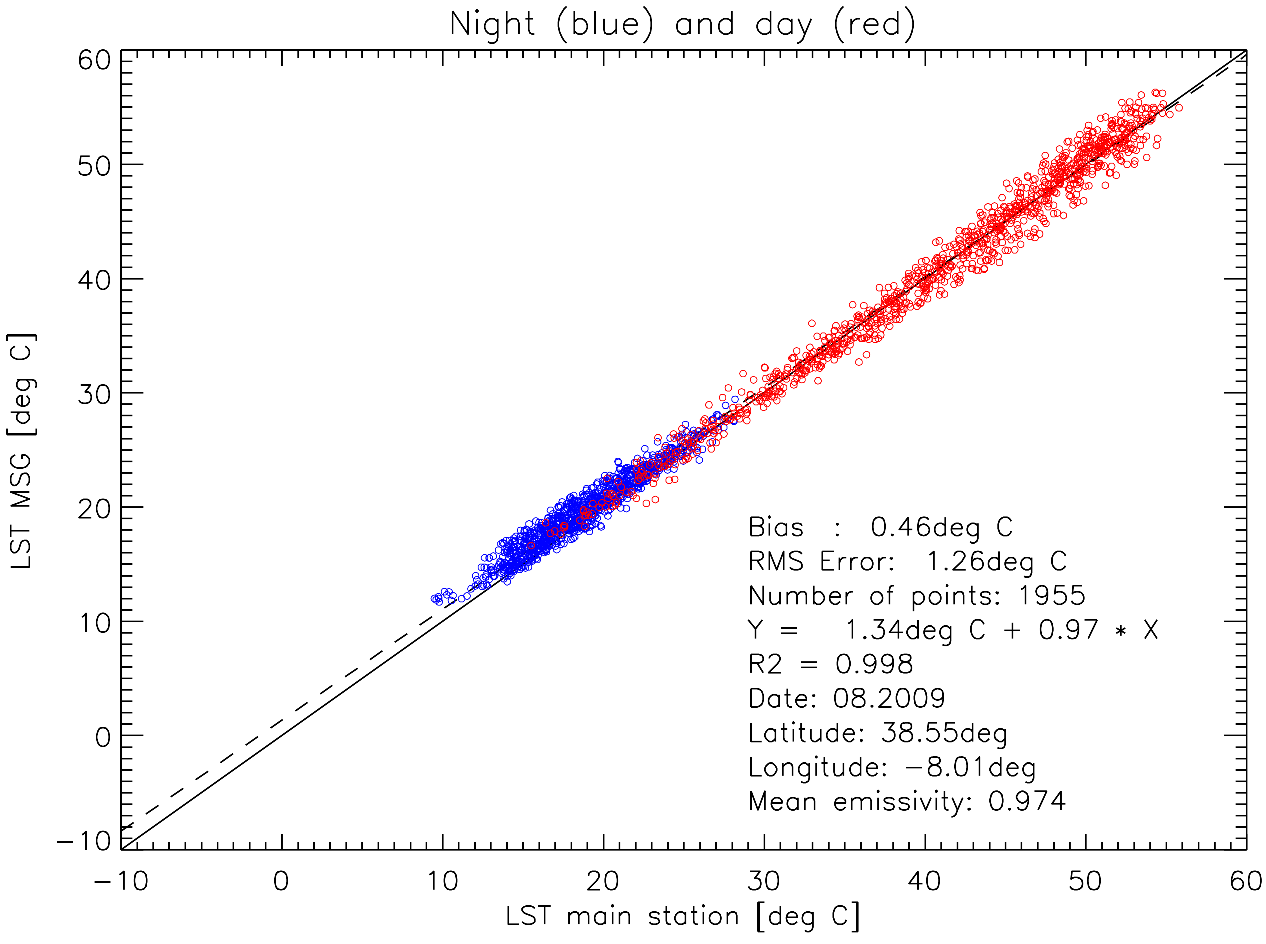
LST validation is a challenge!

IR Radiometer Heitronics KT15.85 IIP

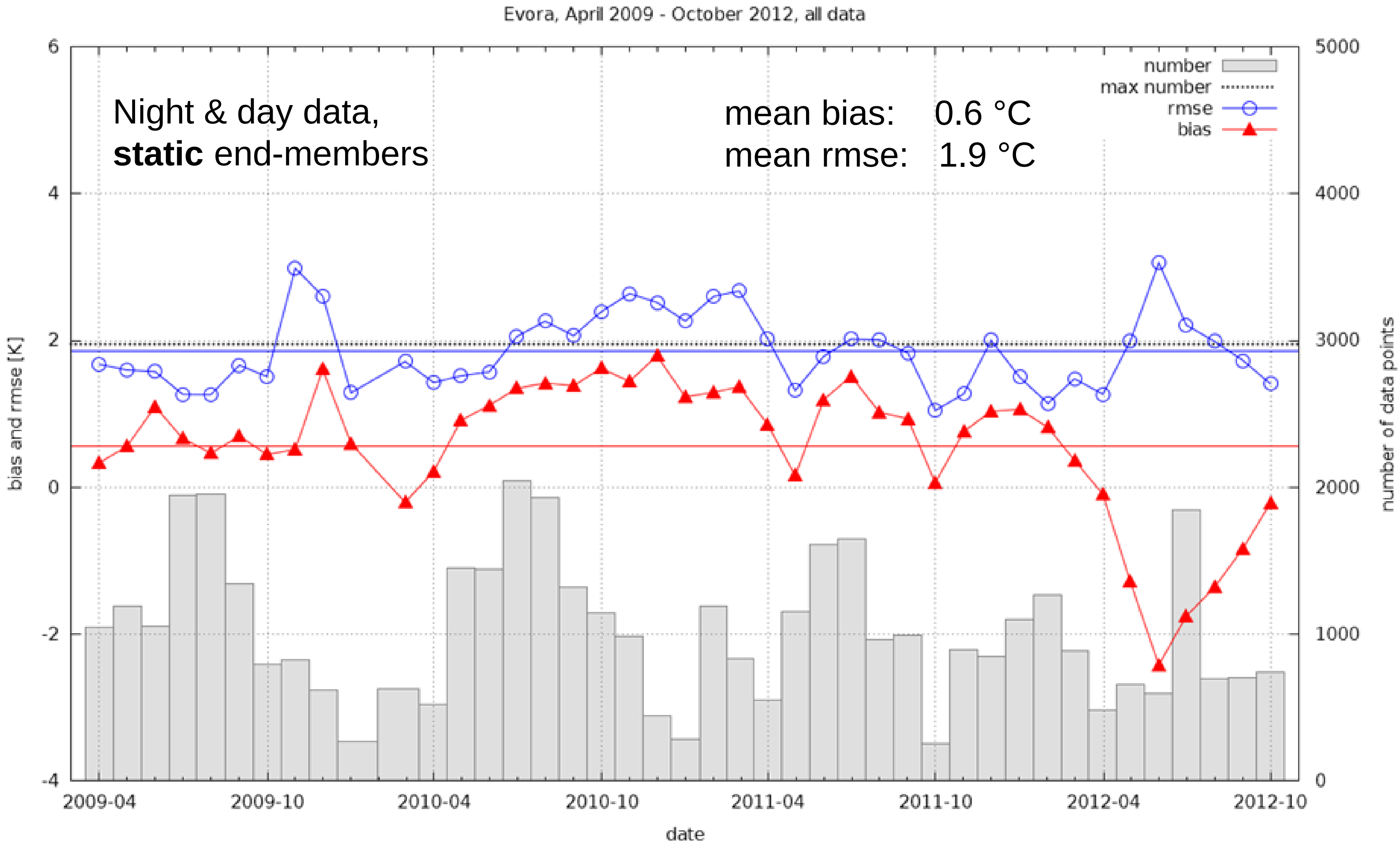
- **chopped**, precision radiometer:
  stability better than **0.12% per year**
- narrow band 9.6µm -11.5µm
- better than **±0.3K** absolute accuracy
- narrow view angle: 8.5°
- separate KT15 for each end-member
  additional KT15 for **sky radiance**
- fast sampling rate of **1 min**

Ground LST vs. MSG LST (LSA SAF)

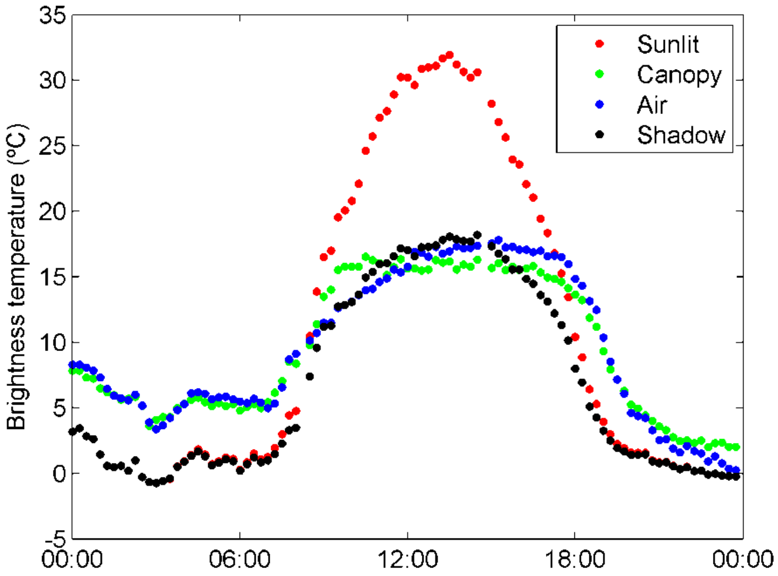
Evora, Portugal, August 2009



LSA SAF LST vs in situ LST (Evora, Portugal)



Impact of viewing & illumination geometry?

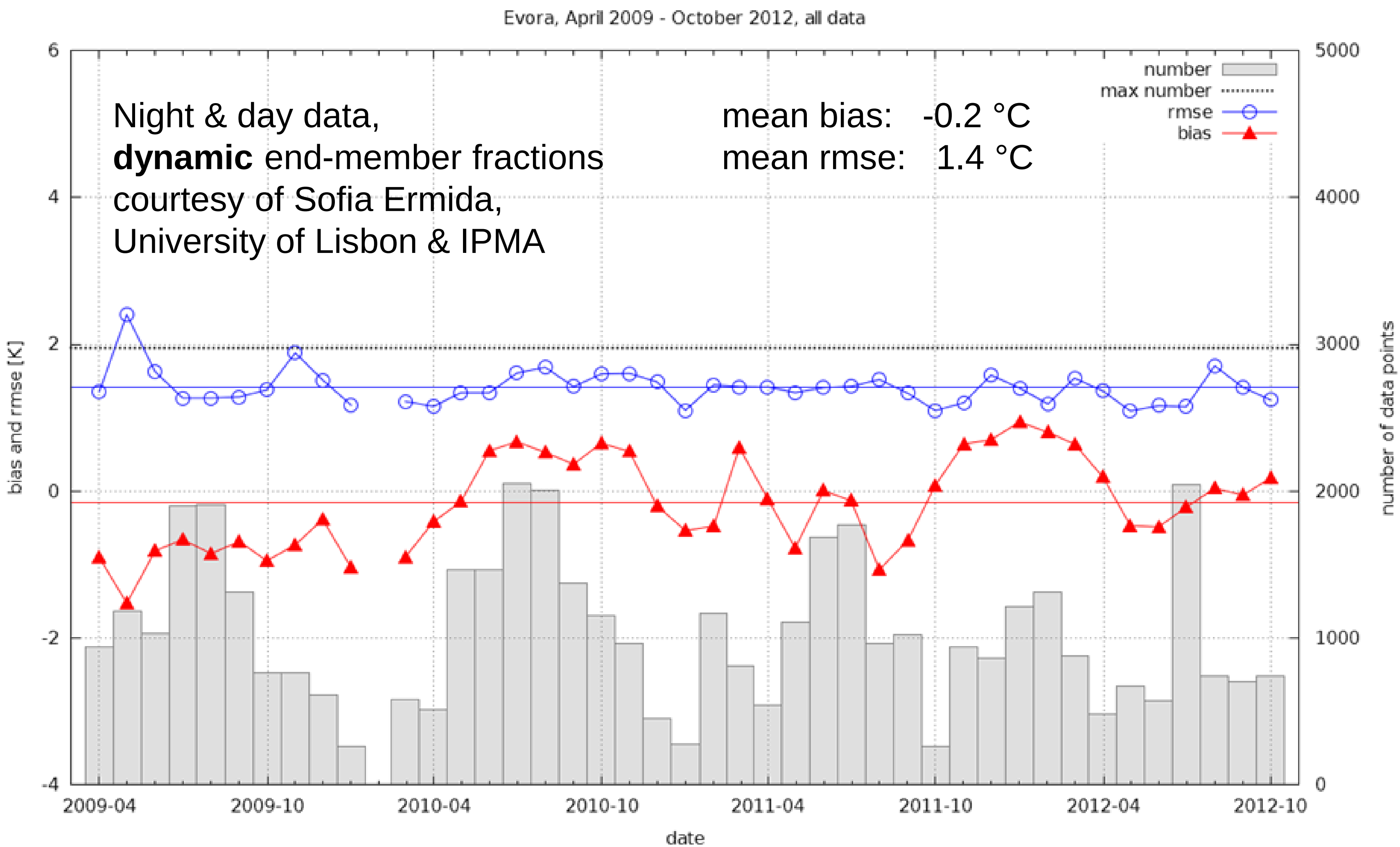


From Ermida et al. (2014), Validation of remotely sensed surface temperature over an oakwoodland landscape — The problem of viewing and illumination geometries. RSE, 148, pp. 16-27.

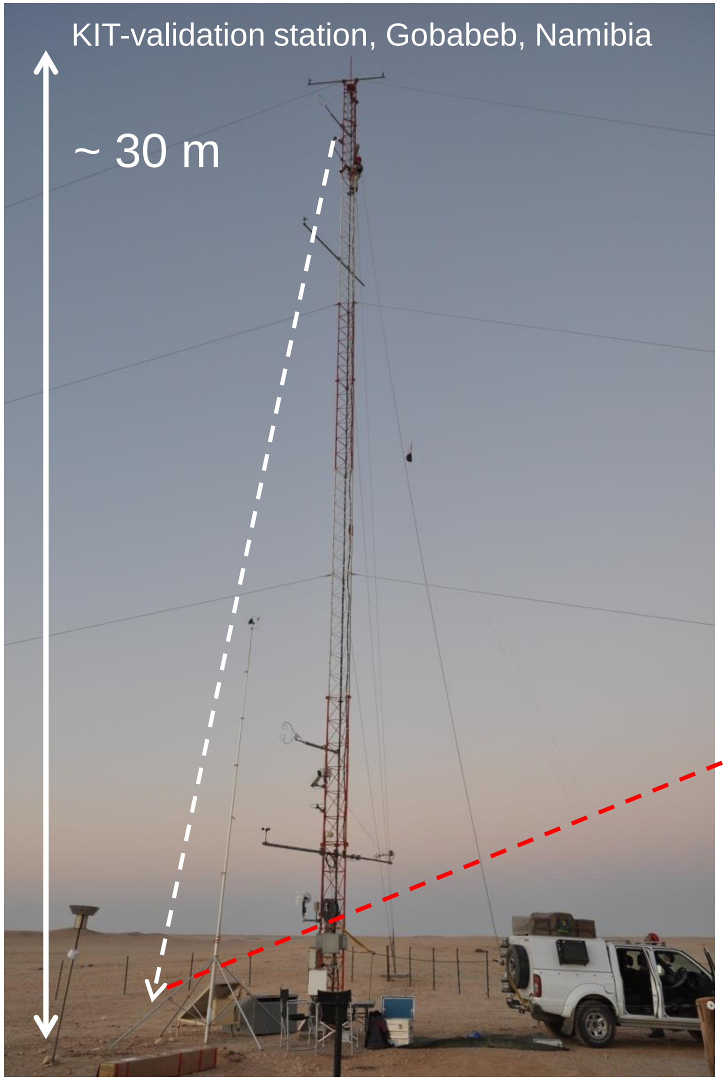
- Generally, end-member cover fractions vary with viewing geometry
- Shaded & sunlit end-member fractions depend on illumination

→ LST validation needs to consider viewing & illumination geometry

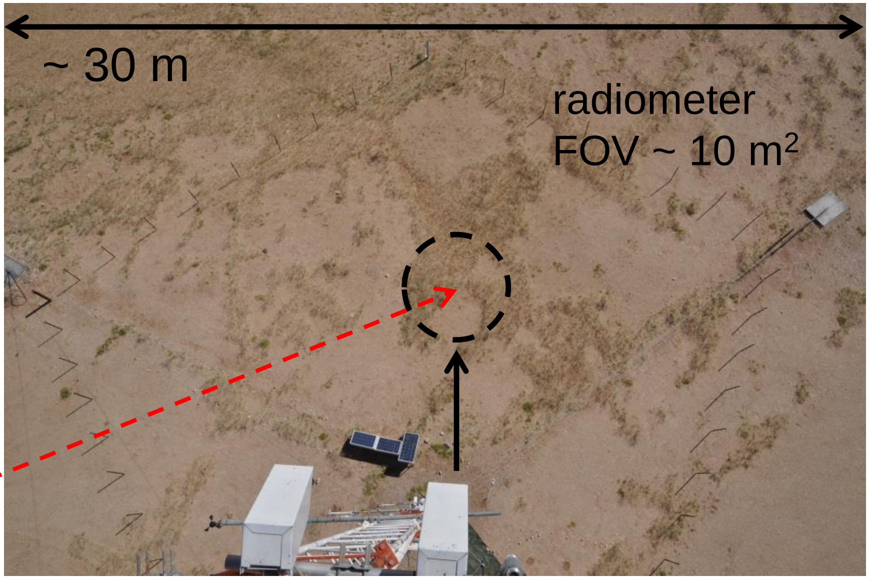
LST validation with dynamic end-member fractions



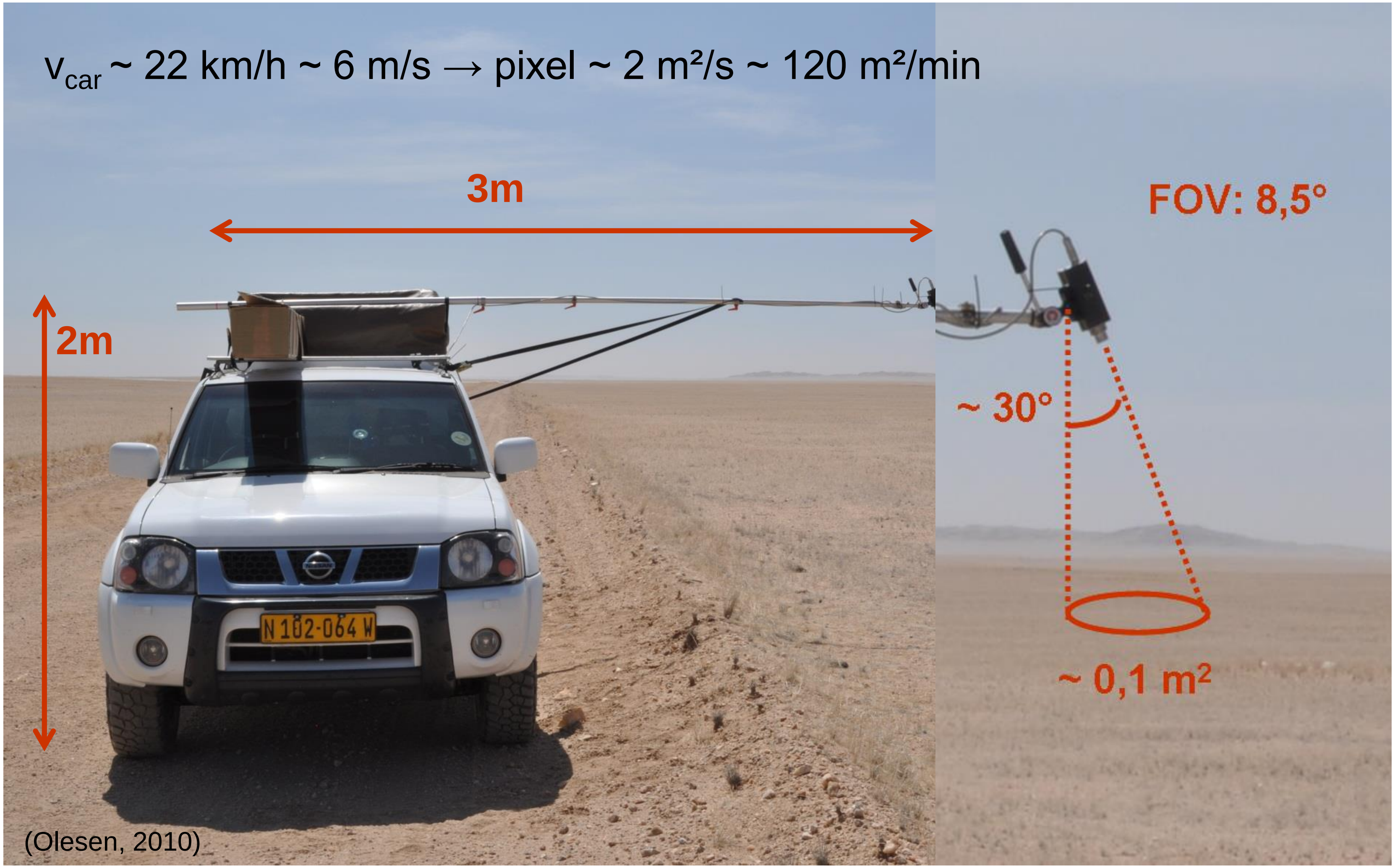
LST validation at Gobabeb, Namiba



… some ‚magic‘ square meters …

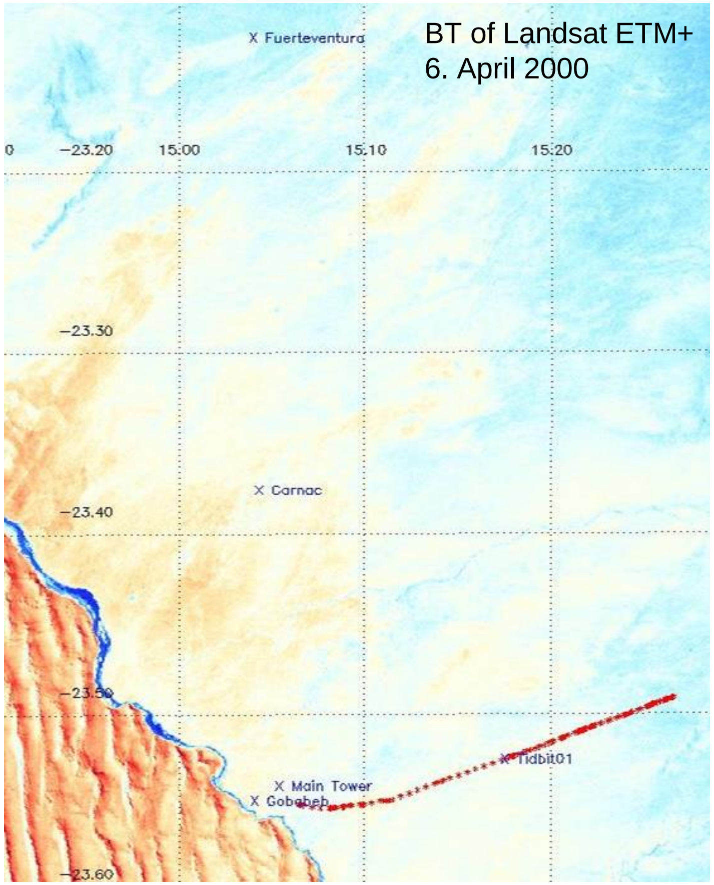


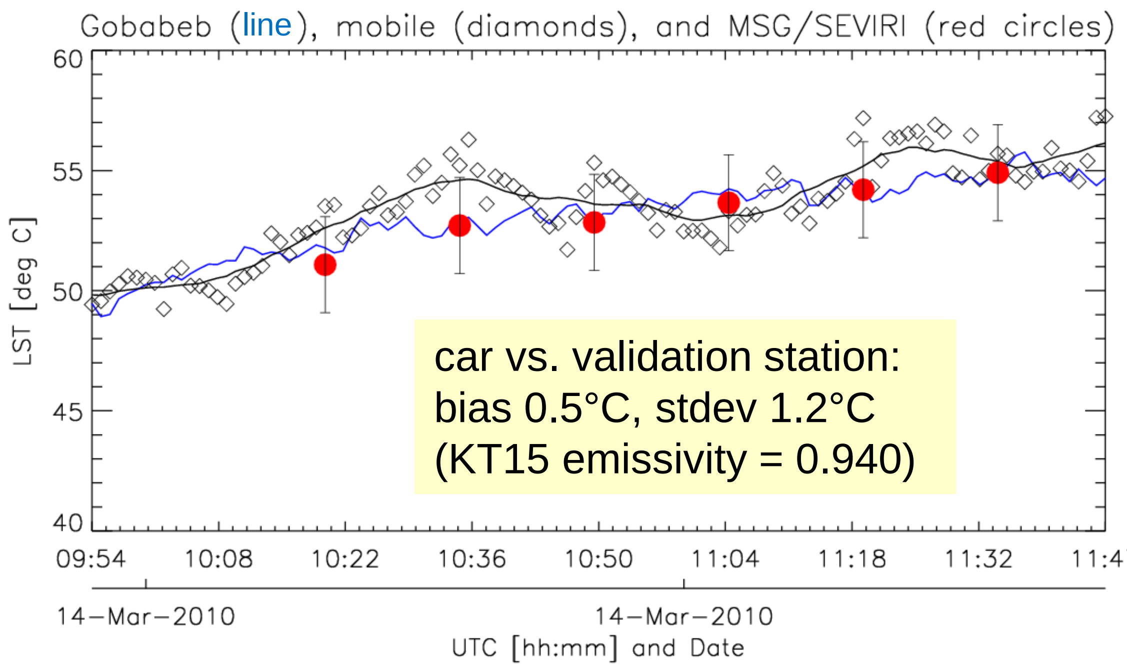
Are the station measurements representative?



Gobabeb field survey 2010 Namib Desert

Karlsruhe Institute of Technology

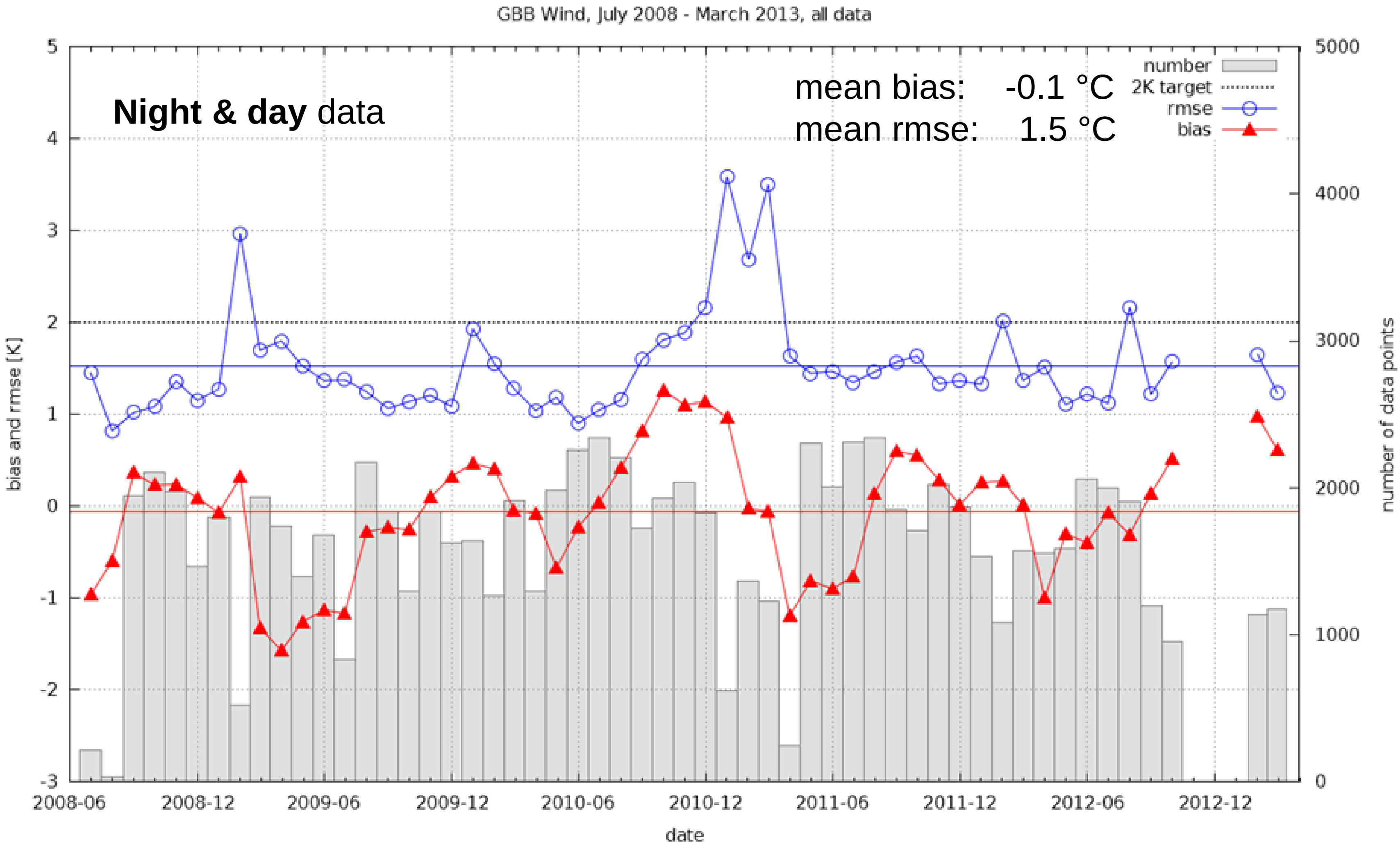




“Car-validation”

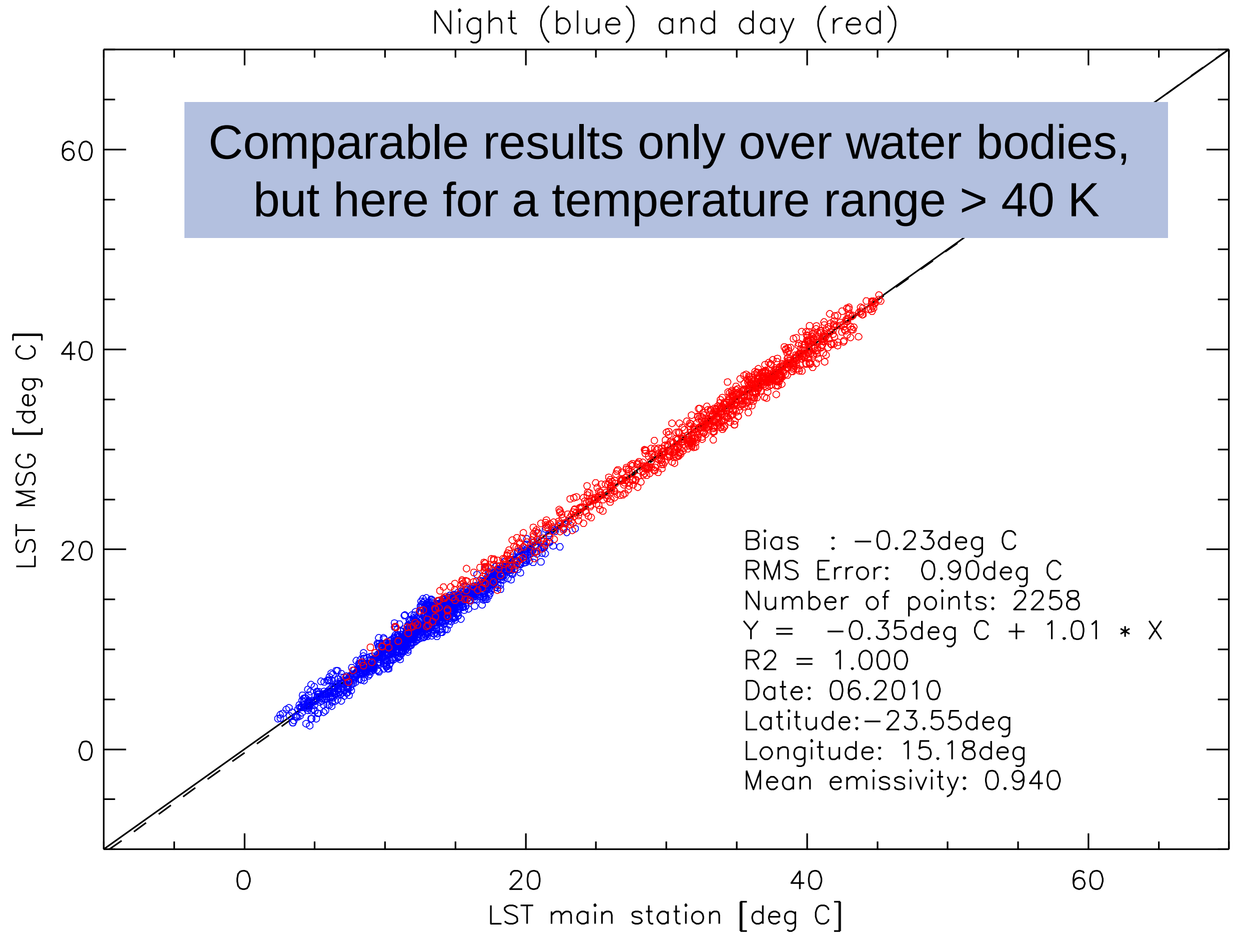
Red crosses x mark track

Gobabeb Ground LST vs. MSG LST

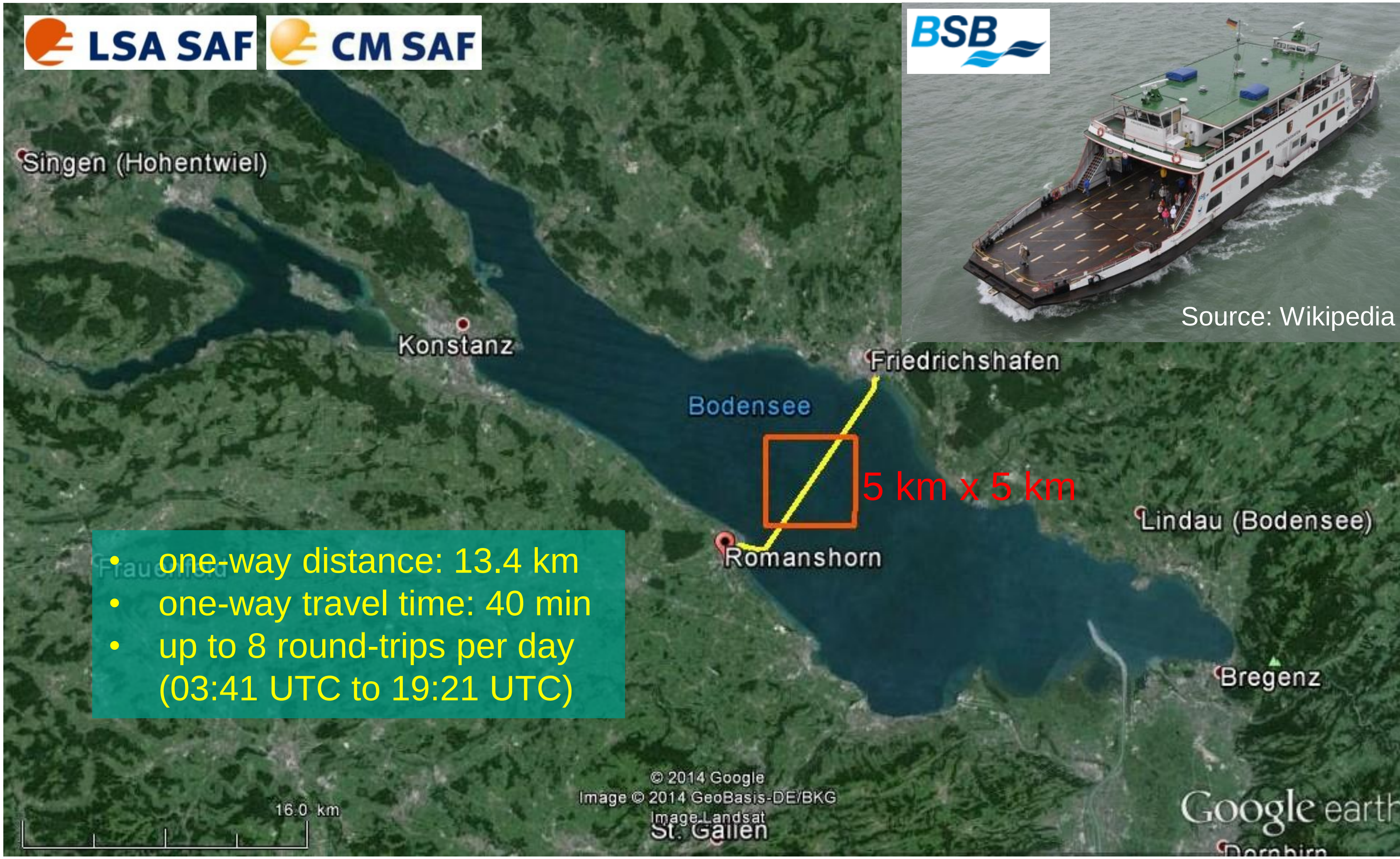


Gobabeb Ground LST vs. MSG LST

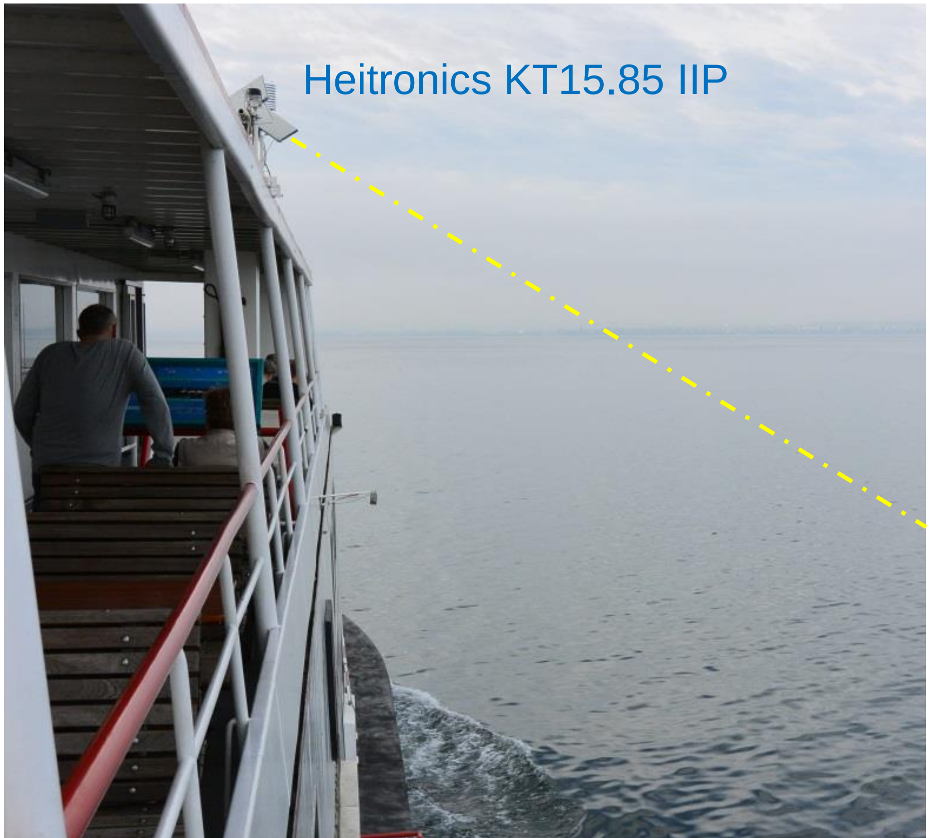
June 2010 (Winter)



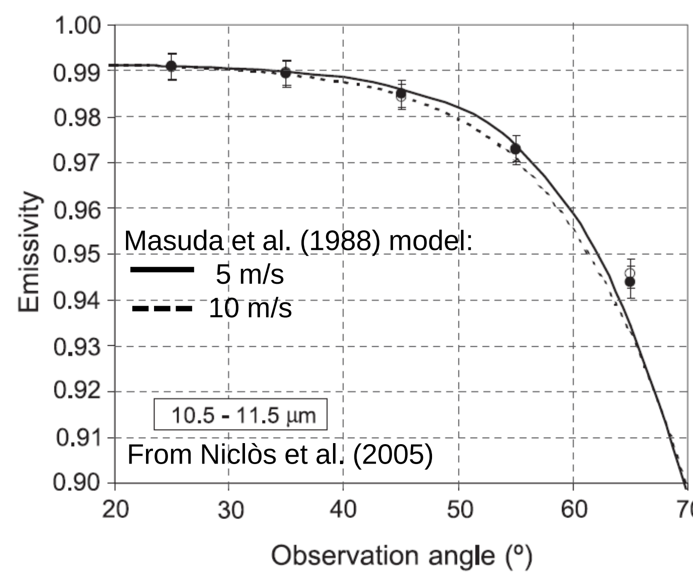
In-situ Measurements on Lake Constance



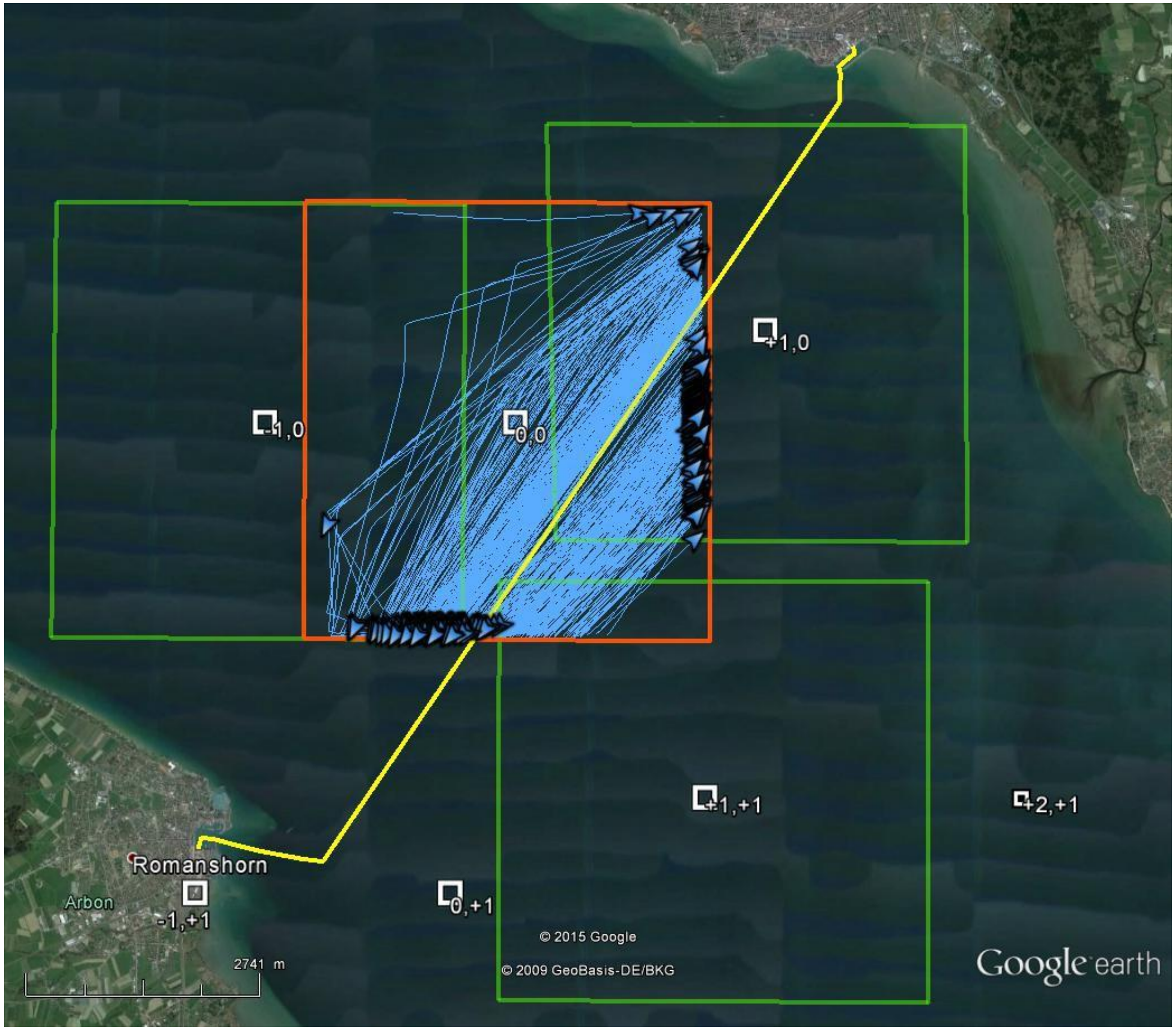
Lake Surface Water Temperature (LSWT): in situ measurements on Lake Constance



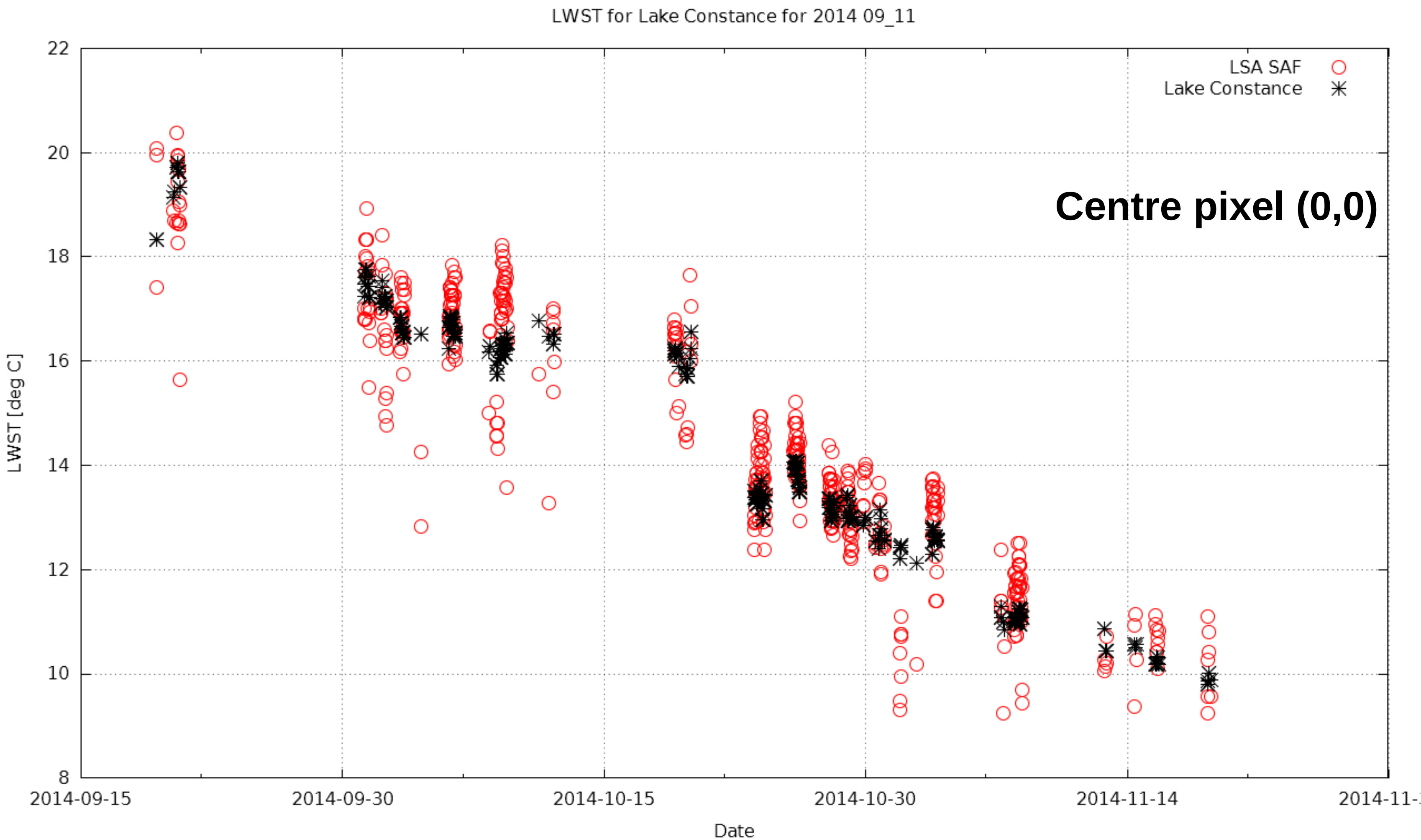
Distance to target: 13 m
FOV Ø: 2.3 m
View angle: 55° (ε = 0.973)



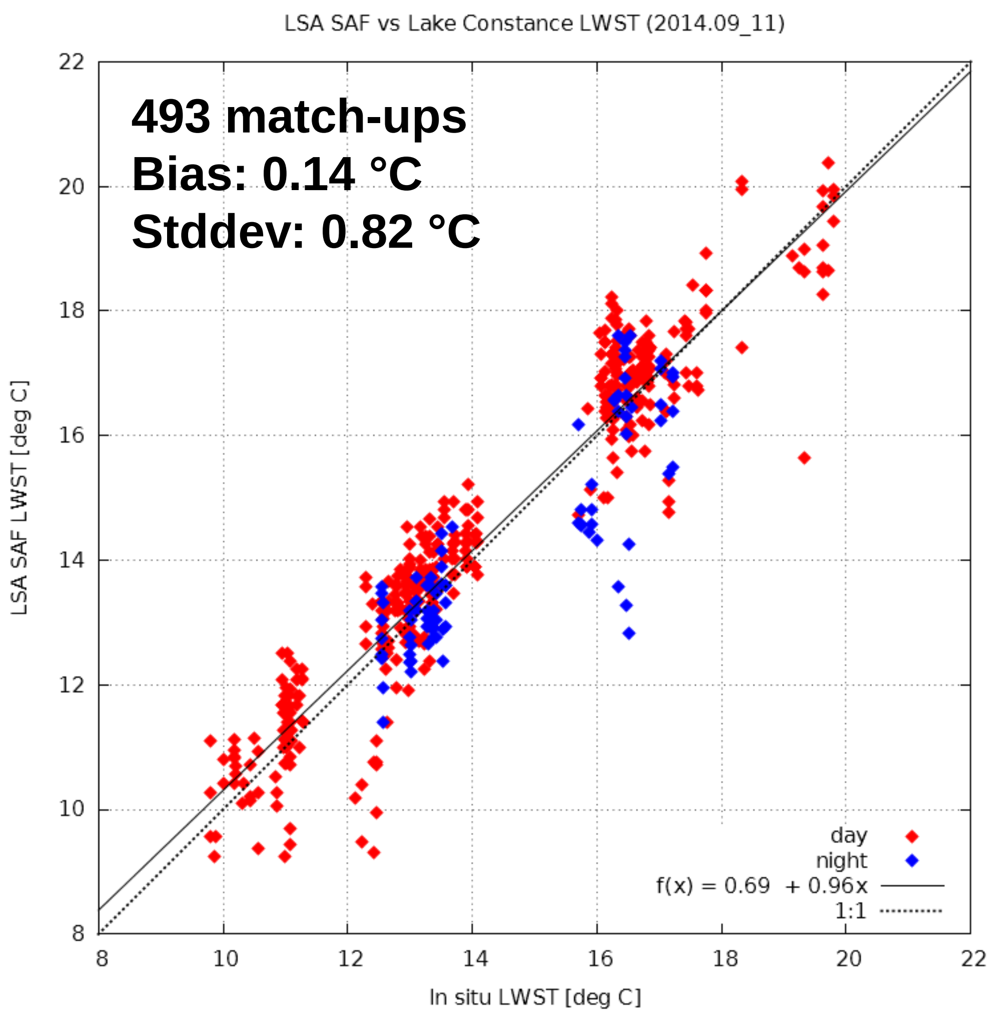
‘Friedrichshafen’ GPS tracks (Sep-Dec 2014)



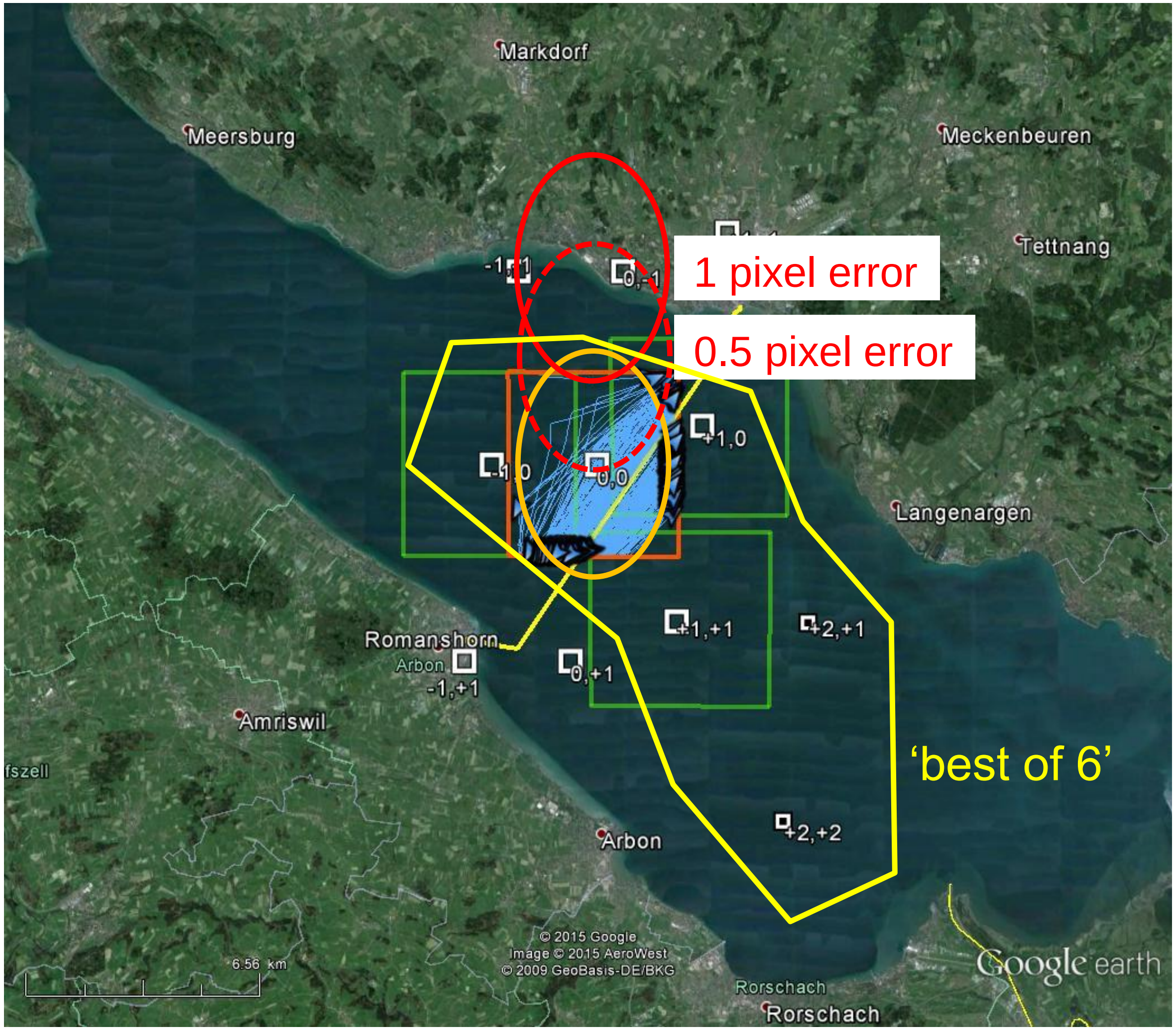
LSA SAF LST & in situ LSWT (Lake Constance)



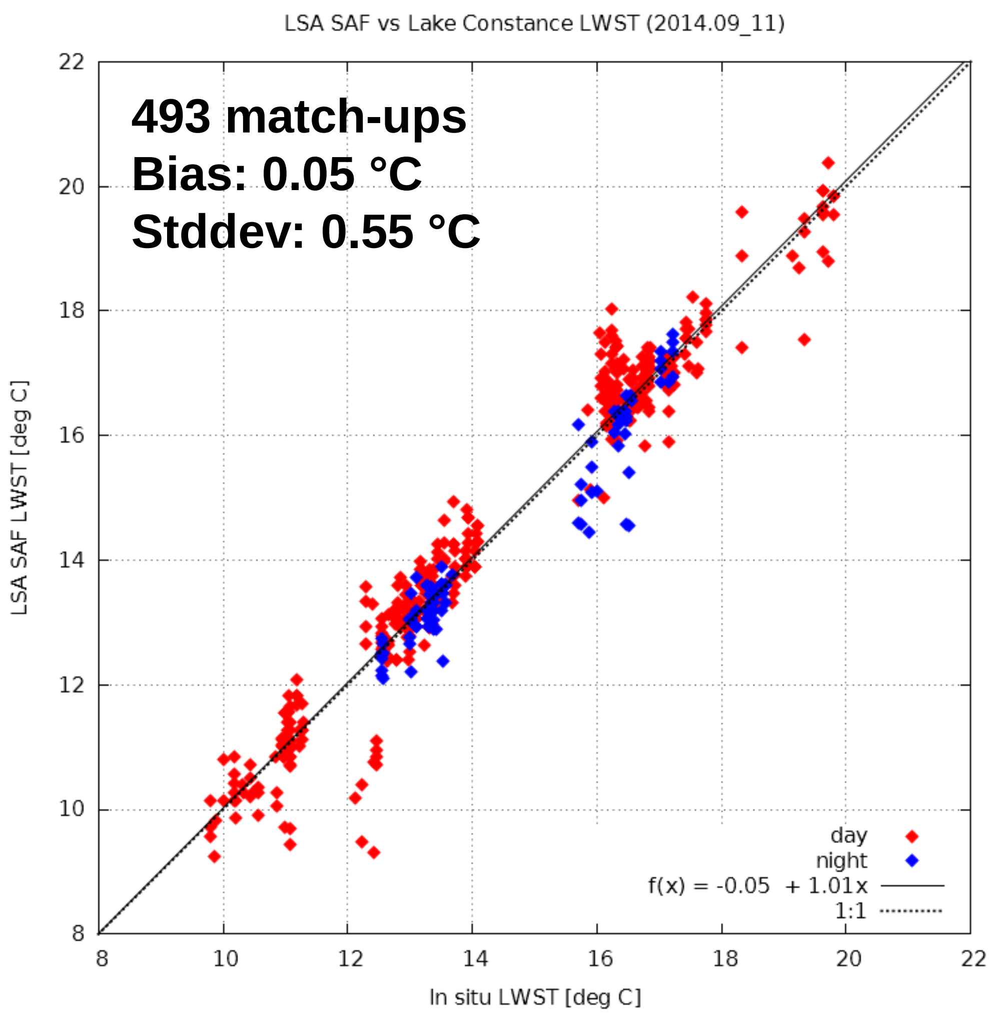
LSA SAF LST vs in situ LSWT (Sep-Nov 2015)



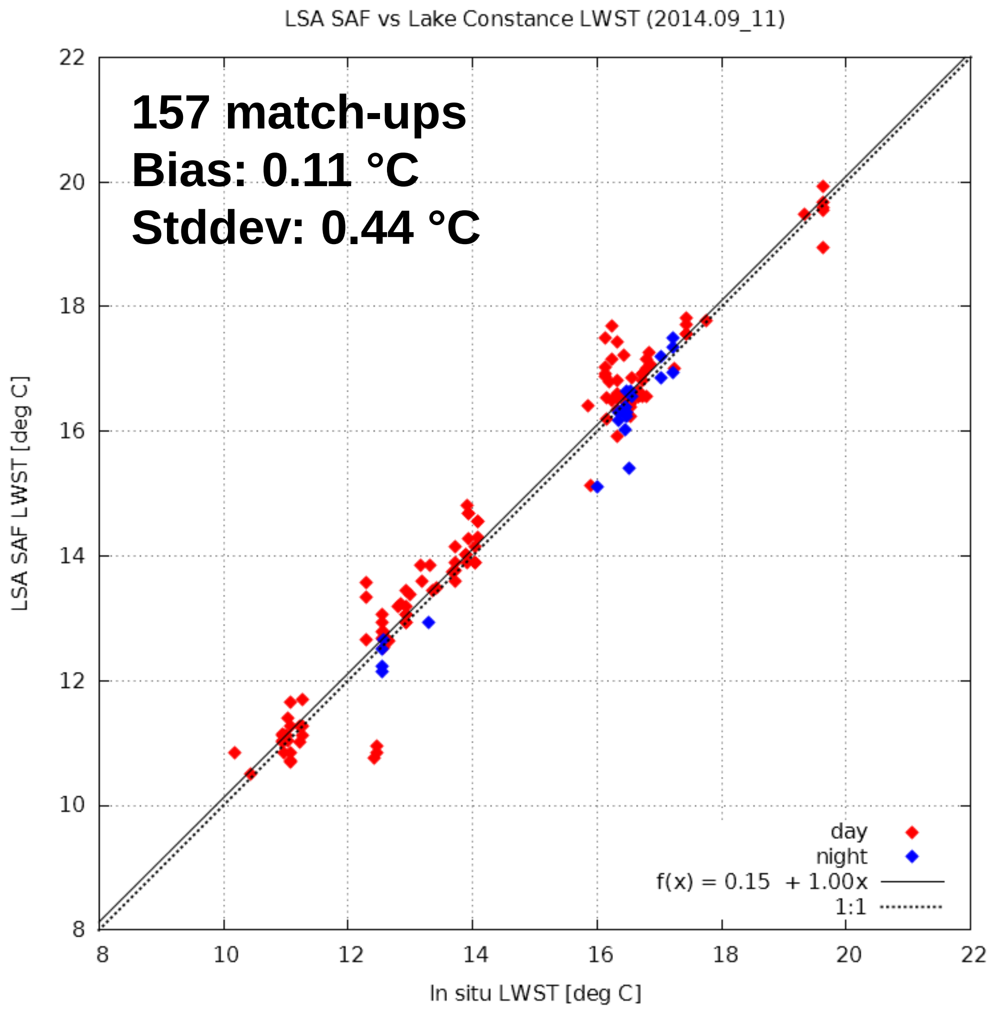
Error: shape & location of MSG/SEVIRI pixel



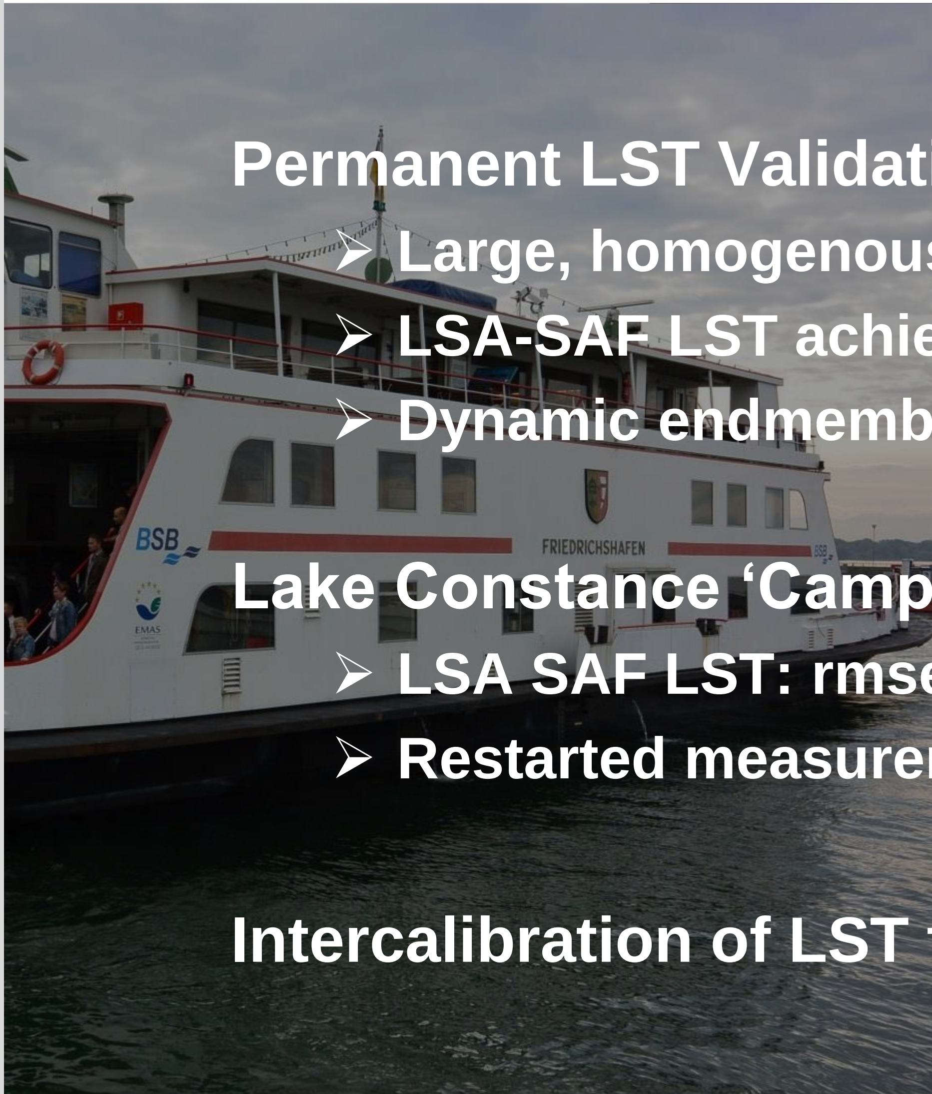
‘Best of 6’ LSA SAF LST vs in situ LSWT

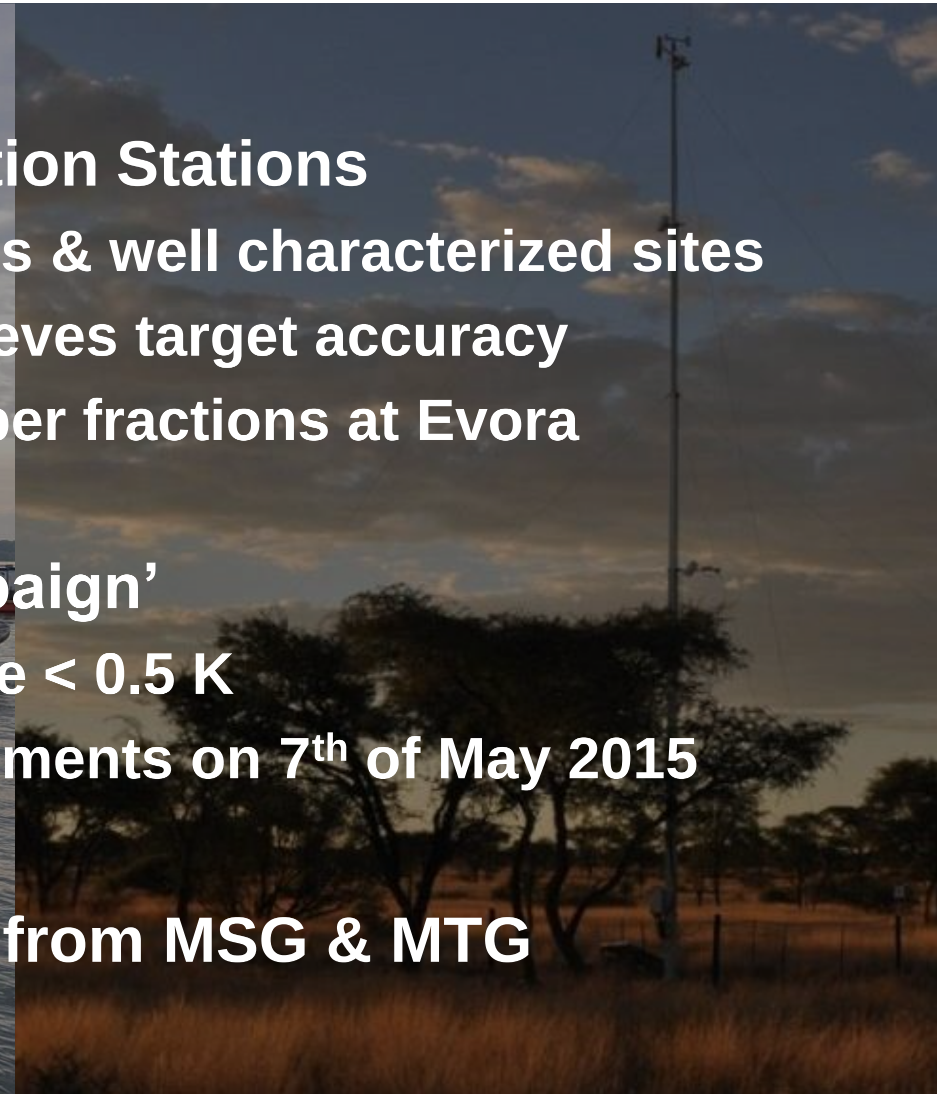


LSWT validation: best of 6 & cloud filter (3x3-1)



Conclusions & Outlook





Permanent LST Validation Stations

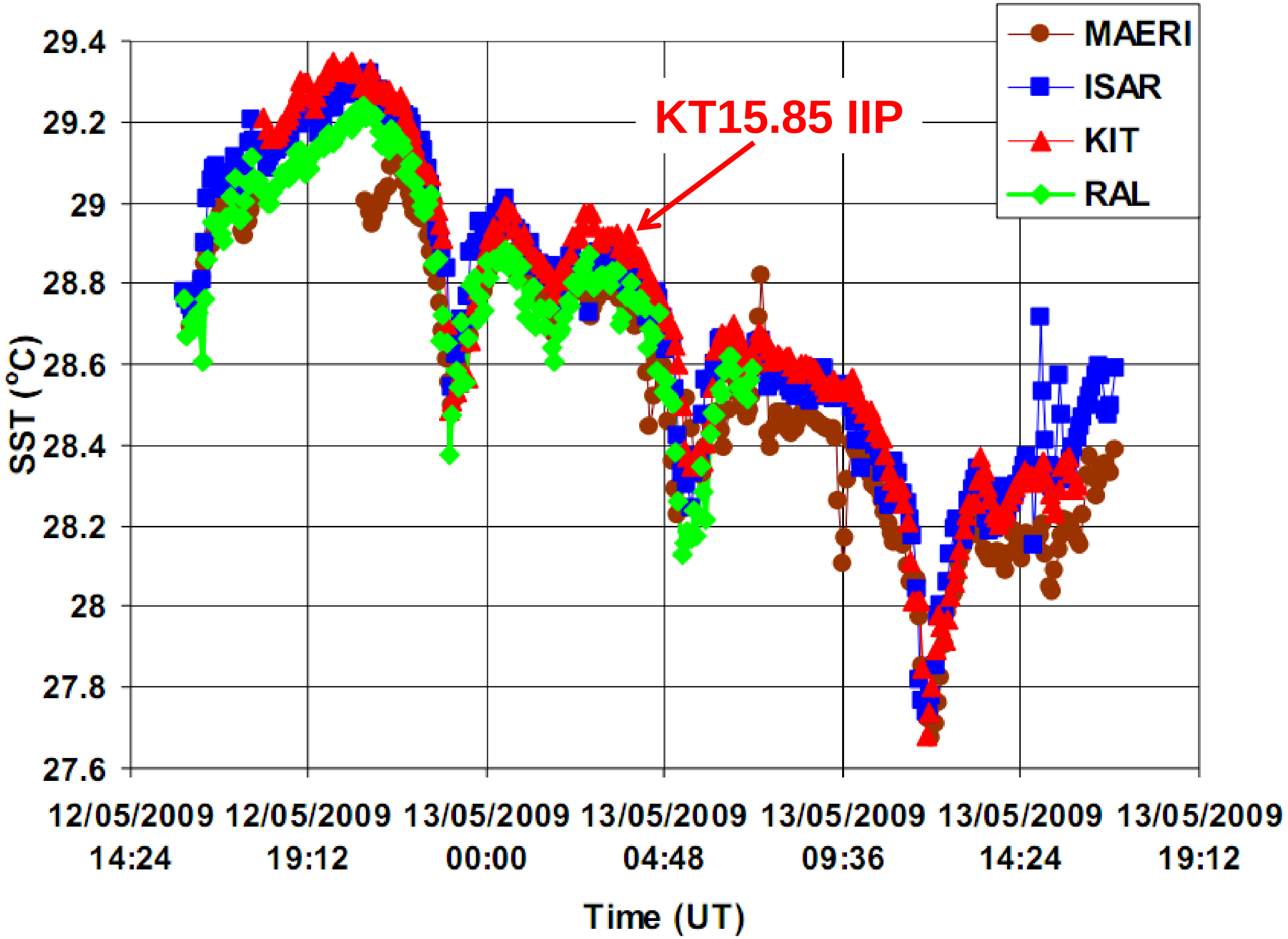
- Large, homogenous & well characterized sites
- LSA-SAF LST achieves target accuracy
- Dynamic endmember fractions at Evora

Lake Constance ‘Campaign’

- LSA SAF LST: rmse < 0.5 K
- Restarted measurements on 7th of May 2015

Intercalibration of LST from MSG & MTG

Sea Surface Temperature (CEOS Comparison)



Recent KIT publications

- Wu, P., Shen, H., Zhang, L., and Göttsche, F.M. (2015), Integrated fusion of multi-scale polar-orbiting and geostationary satellite observations for the mapping of high spatial and temporal resolution land surface temperature. Remote Sensing of Environment, Vol. 156, pp. 169-181.
- Ermida, S.L., Trigo, I.F., DaCamara, C.C., Göttsche, F.M., Olesen, F.S., and Hulley, G. (2014), Validation of remotely sensed surface temperature over an oak woodland landscape -- the problem of viewing and illumination geometries. Remote Sensing of Environment, Vol. 148, pp. 16-27.
- Jimenez-Munoz, J.C., Sobrino, J.A., Mattar, C., Hulley, G., and Göttsche, F.-M. (2014), Temperature and Emissivity Separation from MSG/SEVIRI data. IEEE Transactions on Geoscience and Remote Sensing, Vol. 52, No. 9, pp. 5937-5951.
- Xu, H., Yu, Y., Tarpley, D., Gottsche, F.-M., and Olesen, F.-S. (2014), Evaluation of GOES-R Land Surface Temperature Algorithm Using SEVIRI Satellite Retrievals With In Situ Measurements. IEEE Transactions on Geoscience and Remote Sensing, DOI: 10.1109/tgrs.2013.2276426, ISSN: 0196-2892, Vol. 52, No. 7, pp. 3812-3822.
- Guillevic, P.C., Bork-Unkelbach, A., Göttsche, F.-M., Hulley, G.C., Gastellu-Etchegorry, J.-P., Olesen, F.-S., and Privette, J.L. (2013), Directional viewing effects on Land Surface Temperature products over sparse vegetation canopies -- A multi-sensors analysis. IEEE Geoscience and Remote Sensing Letters, DOI: 10.1109/lgrs.2013.2260319, Vol. 10, No. 6, pp. 1464-1468.
- Göttsche, F.-M., Olesen, F.-S., and Bork-Unkelbach, A. (2013), Validation of land surface temperature derived from MSG/SEVIRI with in-situ measurements at Gobabeb, Namibia. International Journal of Remote Sensing, Vol. 34, No. 9-10, pp. 3069-3083.
- Göttsche, F.-M., and Hulley, G. C. (2012), Validation of six satellite-retrieved land surface emissivity products over two land cover types in a hyper-arid region. Remote Sensing of Environment, Vol. 124, pp. 149-158.
- Guillevic, P.C., Biard, J., Hulley, G., Privette, J.L., Hook, S.J., Olioso, A., Göttsche, F.M., Radocinski, R., Roman, M.O., Yu, Y., and Csiszar, I. (2014), Validation of Land Surface Temperature products derived from the Visible Infrared Imager Radiometer Suite (VIIRS) using ground-based and heritage satellite measurements, Remote Sensing of Environment, Vol. 154, pp. 19–37.
- Tagesson, T., Fensholt, R., Guiro, I., Rasmussen, M.O., Huber, S., Mbow, C., Garcia, M., Horion, S., Sandholt, I., Holm-Rasmussen, B., Göttsche, F.M., Ridler, M.-E., Olen, N., Lundegard Olsen, J., Ehammer, A., Madsen, M., Olesen, F.S., Ardö, J. (2014), Ecosystem properties of semi-arid savanna grassland in West Africa and its relationship to environmental variability. Global Change Biology, doi: 10.1111/gcb.12734.